FRD ACTIVITIES REPORT
September 2006

Research Programs

Smart Balloon

During August and September, FRD launched six NOAA "smart" balloons as part of the Texas Air Quality Study II. The paths of the six smart balloons originating from Houston can be seen in Fig. 1. The NOAA smart balloon design allows the operator to remotely control balloon flight levels to permit sampling of different layers of the atmosphere. The balloons were used to measure ozone concentrations with a state-of-the-art miniature sensor that was designed and built by scientists at the University of New Hampshire. The balloons also included instruments to measure a number of other meteorological variables while immersed in plumes of urban air. Houston has one of the highest levels of ozone in the U.S., and scientists are trying to better understand how the pollutant is exported from "mega-polluted" areas such as Houston and Mexico City and what its impact is on the air quality of the Northern Hemisphere.

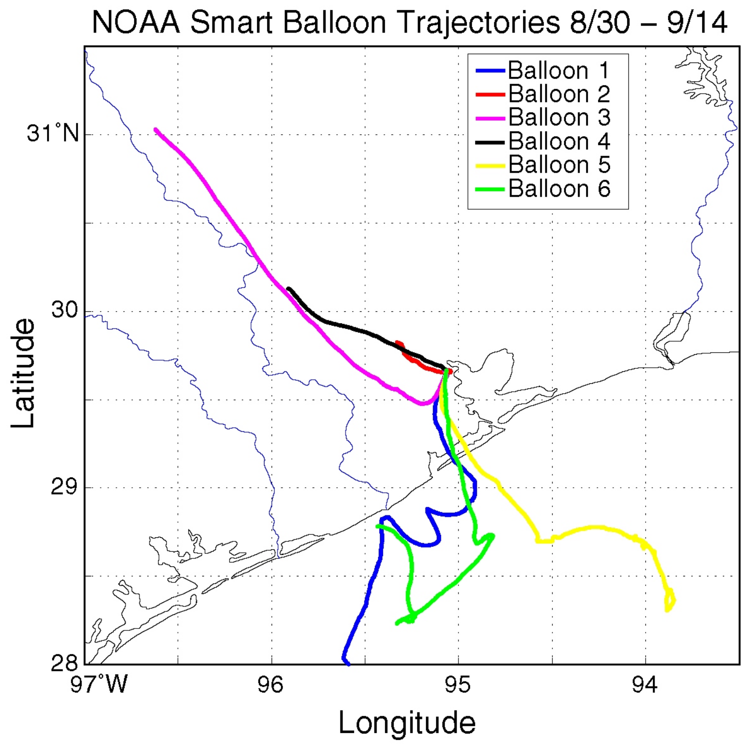

Figure 1. Path of the six smart balloons during the Texas Air Quality Study II.

The first smart balloon, which stayed aloft for about 98 hours or a little more than four days, traveled more than 2,500 kilometers across the Gulf of Mexico before landing in Florida (see August report). It encountered ozone levels in excess of 200 ppb in polluted air over the Gulf. Such high levels of ozone are considered unhealthy under guidelines established by the U.S. Environmental Protection Agency.

"The balloons provide a very unique platform," stated collaborator Robert Talbot, director of the UNH Climate Change Research Center, which is a part of the Institute for the Study of Earth, Oceans, and Space where the miniature ozone sensor was developed. "The real power of the balloons is the continuous observation on spatial scales that other platforms can't do," said

Talbot. For example, a smart balloon, drifting at 10 meters per second in a polluted plume of air, can make much higher resolution measurements than an aircraft traveling ten times faster but flying in and out of the plume.

The balloons provided a new perspective on the flow and dispersion of pollution from the Houston area, and will help scientists learn how these plumes disperse over the Gulf of Mexico in particular, so that computer models can be improved to better simulate and predict those processes. NOAA scientists will work in collaboration with faculty and students from UNH and the University of Hawaii in analyzing the data obtained during the smart balloon flights. (Randy Johnson, 208-526-2129)

Real-time Tracer Analysis Technology

Experiments conducted in the FRD tracer analysis facility have demonstrated a technology that could possibly replace the current reactor-dryer system used in the continuous tracer analyzers. A semi-permeable gas membrane loaned to FRD by Membrane Technology and Research, Inc., successfully removed the oxygen from an air stream allowing an electron capture detector (ECD) to measure tracer concentrations ranging from 49 to over 5,000 pptv (Fig. 2). The separation was incomplete resulting in a high baseline and a non-linear ECD response, but future improvements could make the technology viable.

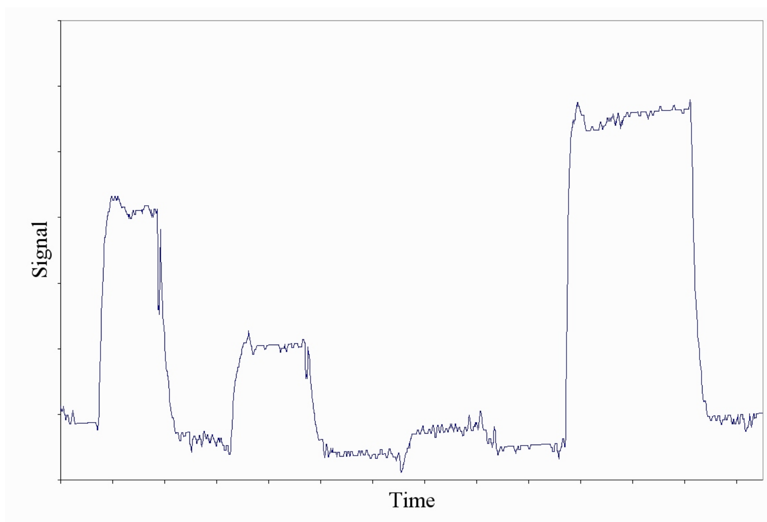

Figure 2. Output from a semi-permeable membrane based continuous analyzer showing the response to tracer concentrations of 1593 ppt, 307 ppt, 49 ppt, and 5240 ppt.

The current continuous tracer analyzers, which are a vital part of FRD's dispersion measurement capabilities, rely on a hydrogen-oxygen reaction to remove the oxygen from the sampled air. This requires tanks of compressed hydrogen and nitrogen for the analyzer to be operated. These are always a safety concern. A semi-permeable membrane requires no compressed gases and would be simpler and safer to operate.

The semi-permeable membrane was also tested as a tracer concentrator and successfully increased the concentration of tracer by a factor of seven. It could possibly be used as a tracer gas concentrator and effectively lower the limit of detection for some tracers. (Roger Carter, 208-526-5745)

Perfluorocarbon Tracer Analysis Development

The development of a perfluorocarbon tracer (PFT) analysis capability at FRD is nearly complete. Two different PFTs (PDCB and PMCH) have been included in the development of this capability. The analysis time is about 5 minutes per sample with an instrument limit of detection (ILOD) of 1 pptv and an instrument limit of quantitation (ILOQ) of approximately 5 pptv for both PDCB and PMCH based on a calibration curve up to 250 pptv. Higher concentrations may affect the accuracy of the curve on the lower end, however. An estimate of the method limit of quantitation (MLOQ) is probably around 10 pptv. Before a more concrete limit can be determined, sampler studies will first need to be conducted.

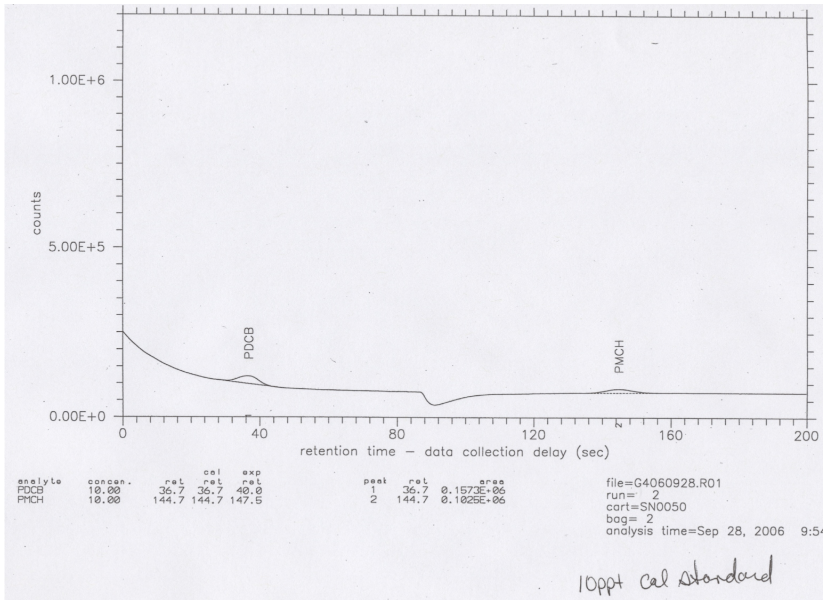

Figure 3. A 10 ppt PDCB and PMCH standard in UHP air.

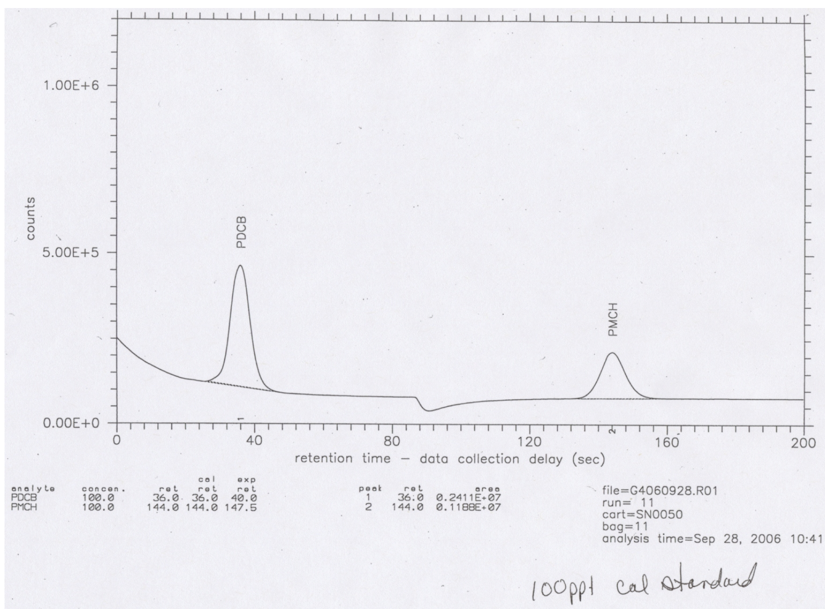

Figure 4. A 100 ppt PDCB and PMCH calibration standard in UHP air.

An example graph of a 10 pptv PDCH and PMCH calibration standard in UHP air can be clearly discerned from the baseline as seen in Fig. 3, while Fig. 4 shows a higher concentration of 100 pptv. In both figures, the very beginning of the chromatogram containing a large oxygen peak is not shown. The dip in the middle of the chromatogram is the point at which the valve switches from the inject position to the load position for the next sample.

Some samples from the MID05 study were analyzed to determine if there were any interferences from this urban air environment which is assumed to be one of the more difficult urban air samples to analyze. The chart recorder output in Fig. 5 shows bag #1 and bag #2 from a rooftop sampler from this study. Bag # 1 shows the concentration of tracers prior to the release. The peak just before to the valve switching dip appeared in all the urban air samples analyzed, but was not seen in any of the calibration or UHP air samples and its identity is unknown. Bag #2 shows the concentration of tracer during the 30 minutes after the first release at 7 am. As can be seen in this figure, there are multiple tracer concentrations including PDCB and a huge concentration of PMCH. The peaks after the PMCH peak are unknown but are suspected to be low level PFT tracers released at the same time.

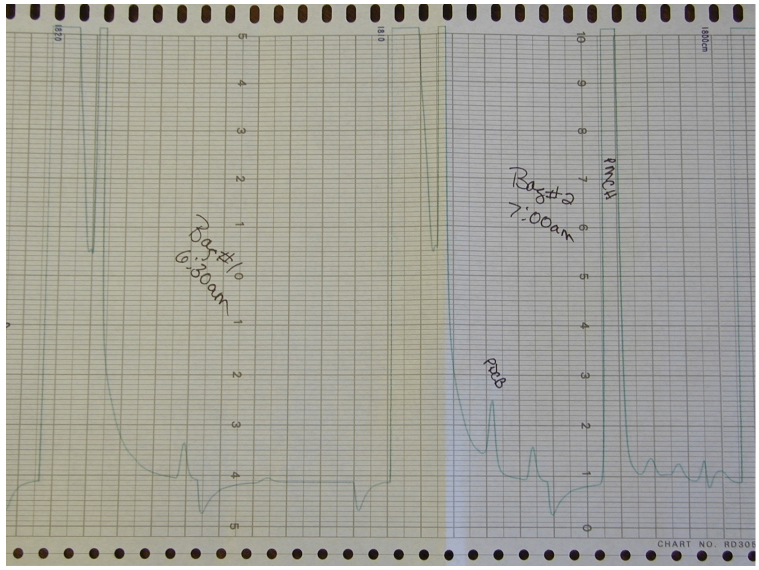

Figure 5. Bag #1 (pre-release of PFTs) and Bag #2 (at start of release).

Figure 6 shows the current analytical column configuration. The oven contains two 30 meter Alumina capillary columns at a temperature of 130˚C. The sample is injected onto the first column and then moves to the second column. After the oxygen, and tracers of interest have moved through the first column and into the second column, the valve is switched to back-flush the first column and dump any later eluding analytes. A reduction in analysis time may be achieved by replacing one or both columns with shorter columns, increasing the oven temperature, adjusting the flows or other timing parameters. The stainless steel round object to the right of the yellow capillary columns is a 10 mL sample loop while the object just under the loop is a 10 port Valco valve. An air heating assembly is positioned under the columns and a circulating fan is placed in the middle of the heating assembly to provide good heat distribution. (Debbie Lacroix)

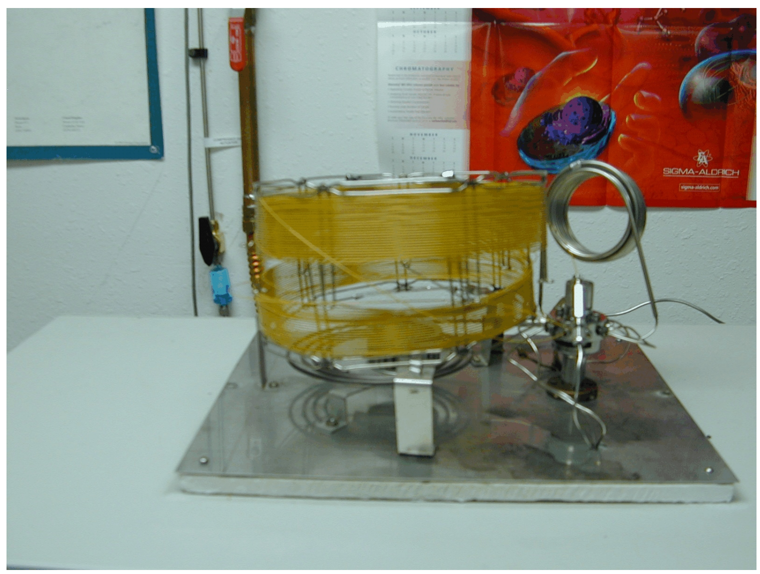

Figure 6. ATGAS oven showing the two 30 meter capillary columns and the 10 mL sample loop.

UrbaNet/ARL

A survey of potential fugitive sources of SF_6 and interferants was conducted in Las Vegas, NV, on September 12-14. The survey consisted of driving a van instrumented with an SF_6 real-time analyzer along the Las Vegas Strip and into and around the downtown area. The survey was conducted over several days. No major sources of SF_6 or SF_6 interferants were discovered. The results indicate that the SF_6 atmospheric tracer could be used in a large scaled atmospheric tracer field study without the fear of fugitive SF_6 tracer sources convoluting the concentration data. (Kirk Clawson, 208-526-2742, and Jason Rich)

As described last month, FRD and ATDD are investigating urban Model Output Statistics (MOS) as an approach for improving wind and turbulence forecasts in urban areas. The basic concept is to generate improved urban meteorology forecasts by blending model outputs and recent local observations using a regression equation. An overview of the concept was given at an UrbaNet meeting held in Las Vegas in late September. The idea received a generally positive response from the meeting participants. (Richard Eckman, 208-526-2740, and Ronald Dobosy, ATDD)

UrbaNet/Urban Dispersion Program

Analysis of the PIGS data from MID05 indicates that flow decoupling in Midtown Manhattan during daytime conditions occurs at wind speeds of less than about 2-3 m s^{-1}. For wind speeds less than this threshold, a good possibility exists that the track of the tracer plume at street level will vary from the wind direction at rooftop levels by as much as 90 degrees. For wind speeds greater than this threshold, the track of the plume at street level will be consistent with the building-top wind direction. The exact wind speed threshold for flow decoupling is a function of the thermal regime (atmospheric stability), characteristics of the urban canopy, and wind direction. Coupled flows tend to occur in daytime conditions in association with well organized wind fields characterized by higher wind speeds and consistent wind directions at all meteorological stations across the metropolitan area. At very low wind speeds, transport by advection is significantly diminished, plume arrival is delayed, plume decay is very slow, and it is possible to realize high concentrations upwind of the release site. In warmer parts of the day, the urban atmosphere becomes increasingly unstable, vertical dispersion is enhanced, and the surficial area of the plume concentration footprint contracts. High rooftop concentrations are a possibility. Significant tracer concentrations can persist for several hours after the release has ended. These results together with other MID05 analyses are included in the draft manuscript *Analysis of Plume Dispersion Characteristics for Continuous Tracer Gas Releases in Midtown Manhattan, MID05*, presently undergoing internal FRD review. (Dennis Finn, 208-526-0566)

The draft manuscript for the JU03 Oklahoma City project, *Analysis of Plume Dispersion, Decay, and Peak-to-Mean Excursions for Continuous Tracer Gas Releases in an Urban Core, Oklahoma City, JU2003*, is also undergoing internal FRD review. A tracer dispersion analysis of the Salt Lake City URBAN 2000 database has been initiated. Preliminary results suggest that topography played a key role in controlling tracer dispersion during the nocturnal experiments. (Dennis Finn, 208-526-0566)

ET Probe

The final revision of the ET probe manuscript submitted to the *Journal of Atmospheric and Oceanic Technology* is expected to be accepted for publication in October. The focus is now turning more towards the hurricane data collected in 2004. A limited overview of these data was presented at a hurricane conference last April, but a more complete analysis has not yet been published. (Richard Eckman, 208-526-2740)

Cooperative Research with DOE NE-ID (Idaho National Laboratory)

FRD is currently negotiating a new Interagency Agreement (IAG) for the ongoing partnership with DOE/INL. Funding levels for the new IAG are still uncertain. At first the indications were that FRD may continue to be flat funded as in previous years. Later, FRD received word that there was a better chance of an increase in funding levels. At current flat funding levels, FRD can no longer continue the range of activities that were performed under the earlier IAGs. Contingency plans have been developed in the event the new IAG funding falls short. These plans include possible cuts in EOC support, Mesonet data distribution, and dispersion modeling. A couple of Mesonet towers may also be deactivated. (Kirk Clawson, 208-526-2742, and Richard Eckman)

Emergency Operations Center (EOC)

The INL Annual Exercise was conducted at the EOC on September 26. The exercise began with a waste spill at RWMC caused by a forklift accident. Another mock incident began during the exercise with a fire at a building within the MFC. The NOAA team provided meteorological support, operated the NOAA MDIFF transport and dispersion model, and interpreted its output for emergency response personnel. (Roger Carter, 208-526-2745, Neil Hukari, and Dennis Finn)

A quarterly Assessment Specialists Drill was held in the EOC on September 21. The DOE IAG funding agreement with FRD was among the items discussed. A list of potential reductions in FRD activities, including severely reduced support of the EOC was presented. The Assessment Specialists indicated their support of FRD activities in the EOC and expressed their strong concern at the potential reduction in FRD support of the EOC. No contingency plans for EOC support were identified if full funding for FRD is not forthcoming. (Kirk Clawson, 208-526-2742)

Other Activities

Papers

Eckman, R. M., R. J. Dobosy, D. L. Auble, T. W. Strong, T. L. Crawford, 2006: A pressure-sphere anemometer for measuring turbulence and fluxes in hurricanes. *Journal of Atmospheric and Oceanic Technology*. (In review)

Finn et al, 2007: Analysis of Plume Dispersion Characteristics for Continuous Tracer Gas Releases in Midtown Manhattan, MID05. (FRD review)

Finn et al, 2007: Analysis of Plume Dispersion, Decay, and Peak-to-Mean Excursions for Continuous Tracer Gas Releases in an Urban Core, Oklahoma City, JU2003. (FRD review)

Safety

The safety video “Wasps & Spiders” was shown at the monthly staff meeting. (Debbie Lacroix, 208-526-9997).

Travel

Randy Johnson, 1-16 September 2006, Houston, TX, for Texas Air Quality Study II (TEXAQSII).

Shane Beard, 1-17 September 2006, Houston, TX, for the Texas Air Quality Study II (TEXAQSII).

Kirk Clawson, 12-14 September 2006, Las Vegas, NV, for fugitive SF_6 study.

Jason Rich, 12-14 September 2006, Las Vegas, NV, for fugitive SF_6 study.

Kirk Clawson, 26-28 September 2006, Las Vegas, NV, to attend an UrbaNet planning meeting.

Richard Eckman, 26-28 September 2006, Las Vegas, NV, to attend an UrbaNet planning meeting.

Training

Roger Carter attended Northwest Speed School GC\LC\MS Seminar Series on Sept. 29, 2006.

Personnel

Debbie Lacroix, FRD Chemist, announced her intention to accept a position with Portage Environmental as a Senior Chemist. Her last day will be October 10.